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Indian Standard

COAXIAL COMMUNICATION CABLES

PART 1-122 ELECTRICAL TEST METHODS — TEST FOR CROSS-TALK BETWEEN COAXIAL CABLES

ICS 33.120.10

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NEW DELHI 110002

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Wires, Cables, Waveguides and Accessories Sectional Committee, LITD 6

NATIONAL FOREWORD

This Indian Standard (Part 1-122) which is identical with IEC 61196-1-122 : 2006 'Coaxial communication cables — Part 1-122: Electrical test methods — Test for cross-talk between coaxial cables' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Wires, Cables, Waveguides and Accessories Sectional Committee and approval of the Electronics and Information Technology Division Council.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appear to the following International Standard for which Indian Standard also exists. The corresponding Indian Standard which is to be substituted in its place is listed below along with its degree of equivalence for the edition indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 61196-1 : 2005 Coaxial communication cables — Part 1: Generic specification — General, definitions and requirements	IS/IEC 61196-1 : 2005 Coaxial communication cables: Part 1 Generic specification — General, definitions and requirements	Identical

Only English language text has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not the same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

COAXIAL COMMUNICATION CABLES

PART 1-122 ELECTRICAL TEST METHODS — TEST FOR CROSS-TALK BETWEEN COAXIAL CABLES

1 Scope

This part of IEC 61196 applies to coaxial communications cables. It specifies a test method for determining the cross-talk between coaxial cables for use in communications systems. This method is applicable for the measurement of the cross-talk between coaxial cables of the same type, but also different types (for example, different dimensions, different impedance, different velocity etc.). It is also applicable for multi-coaxial or hybrid-cables.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61196-1, *Coaxial communication cables – Part 1: Generic specification – General, definitions and requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61196-1 apply.

4 Measurement

4.1 Equipment

The measuring set-up is shown in Figure 1 and consists of:

- a signal generator with the same characteristic impedance as the cable under test or with an impedance adapter, completed by a power amplifier if necessary for very high cross-talk attenuation;
- a receiver with a calibrated step attenuator, completed by a pre-amplifier if necessary for very high cross-talk attenuation;
- or a network analyser (which includes the generator and the receiver);
- load resistor with an impedance equal to the nominal impedance of the cable under test.

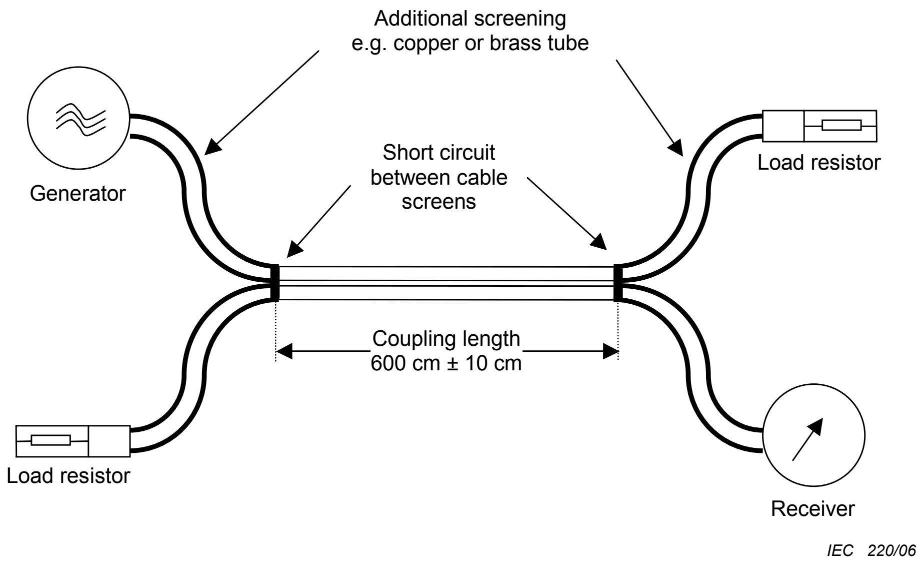

Figure 1 – Test set-up (far end cross-talk)

4.2 Cable under test

4.2.1 Two separate cables

Two samples of 650 cm ± 10 cm are placed next to each other and shall be fixed tightly together over the coupling length of 600 cm ±10 cm, for example by using adhesive tape in an interval of maximum 10 cm. The outer conductors are short circuited at the near end and the far end. The distance between the two short circuits is the coupling length of 600 cm ± 10 cm. The distance between each short circuit and the cable end shall be approximately 25 cm. To avoid the coupling outside the coupling zone, the part between the cable end and the short circuit may be screened additionally, for example with a copper or brass tube. Special care should also be taken in mounting the connectors and choosing connectors with low transfer impedance.

4.2.2 Multi-coaxial or hybrid-cables

On a sample of 650 cm ± 10 cm, the outer sheath shall be removed for approximately 25 cm from each side of the sample so that the elementary cables are accessible. The outer conductors/screens of all elementary cables shall be short circuited at the near end and far end. The distance between the two short circuits is the coupling length of 600 cm ± 10 cm. The distance between each short circuit and the cable end shall be approximately 25 cm. To avoid the coupling outside the coupling zone, the part between the cable end and the short circuit may be screened additionally, for example with a copper or brass tube. Special care should also be taken in mounting the connectors and choosing connectors with low transfer impedance. The elementary cables not under test need not to be terminated.

4.3 Procedure

The near end and far end cross-talk shall be measured from both sides in the specified frequency range (resulting in 4 measurements).

5 Expression of test results

$$a_{\mathrm{X}} = a_{\mathrm{meas}} - a_{\mathrm{z}} + amp \qquad (1)$$

where

a_{X} is the cross-talk attenuation in decibels (dB);

a_{meas} is the measured attenuation (equal $-S_{21}$ respectively $-S_{12}$) in decibels (dB);

a_{z} is the additional attenuation of eventually inserted impedance matching adapters, if not otherwise eliminated for example by the calibration, in decibels (dB);

amp is the amplification of the eventually used power and/or pre amplifier.

6 Requirement

The minimum cross-talk attenuation of all 4 measurements shall comply with the value indicated in the relevant sectional or detail specification.

Annex A
(informative)

Theoretical background

A.1 General

The cross-talk between two coaxial lines is dependent on the surface transfer impedance of the cables, the velocities and the matching conditions. In the following, the theoretical relations are shown.

A.2 Equivalent circuit

The equivalent circuit for the cross-talk measurement between coaxial lines is shown in Figure A.1. The equivalent circuit consists of the matched primary or disturbing circuit (Z_1, Z_{T1}, γ_1), the matched secondary or disturbed circuit (Z_2, Z_{T2}, γ_2) and a third circuit (Z_3, γ_3, Z_A, Z_B).

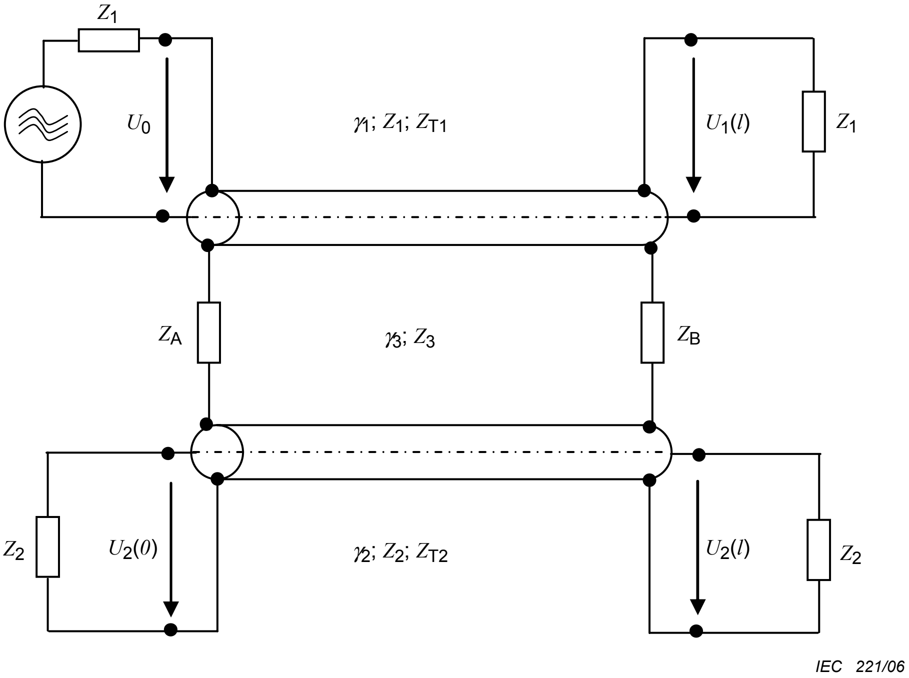

Figure A.1 – Equivalent circuit

A.3 Cross-talk calculation

A.3.1 Any load conditions

For the general configuration with any load conditions in the three circuits as shown in Figure A.1, one obtains:

a) Near end cross-talk $F_{\mathrm{n}} = \dfrac{U_2'(0)}{U_0}$:

$$F_{\mathrm{n}} = -\frac{Z_{\mathrm{T1}} Z_{\mathrm{T2}}}{2 Z_1 Z_3} \int_0^l dy \int_0^l \frac{e^{-\gamma_1 x - \gamma_2 y} K_{\mathrm{n}}(x, y)}{\tanh(\gamma_3 x + \Gamma_A) + \tanh(\gamma_3 (l - x) + \Gamma_B)} dx \qquad \text{(A.1)}$$

$$K_{\mathrm{n}}(x, y) = \frac{\cosh(\gamma_3 y) + \dfrac{Z_A}{Z_3} \sinh(\gamma_3 y)}{\cosh(\gamma_3 x) + \dfrac{Z_A}{Z_3} \sinh(\gamma_3 x)} \qquad \text{(A.2)}$$

b) Far end cross-talk $F_{\mathrm{n}} = \dfrac{U_2'(l)}{U_0}$:

$$F_{\mathrm{n}} = -\frac{Z_{\mathrm{T1}} Z_{\mathrm{T2}}}{2 Z_1 Z_3} \int_0^l dy \int_0^l \frac{e^{-\gamma_1 x - \gamma_2 (l - y)} K_{\mathrm{f}}(x, y)}{\tanh(\gamma_3 x + \Gamma_A) + \tanh(\gamma_3 (l - x) + \Gamma_B)} dx \qquad \text{(A.3)}$$

$$K_{\mathrm{f}}(x, y) = \frac{\cosh(\gamma_3 (l - y)) + \dfrac{Z_B}{Z_3} \sinh(\gamma_3 (l - y))}{\cosh(\gamma_3 (l - x)) + \dfrac{Z_B}{Z_3} \sinh(\gamma_3 (l - x))} \qquad \text{(A.4)}$$

where

$$\Gamma_A = ar \tanh \frac{Z_A}{Z_3} \qquad \text{(A.5)}$$

$$\Gamma_B = ar \tanh \frac{Z_B}{Z_3} \qquad \text{(A.6)}$$

A.3.2 Third circuit short circuited

In the case of a matched primary and secondary circuit, where both are equal, and a short circuited third circuit, one gets:

$$Z_{\mathrm{A}} = Z_{\mathrm{B}} = 0 \qquad \text{(A.7)}$$

$$\gamma_1 = \gamma_2 = \gamma \qquad \text{(A.8)}$$

$$Z_1 = Z_2 = Z \qquad \text{(A.9)}$$

$$Z_{\mathrm{T1}} = Z_{\mathrm{T2}} = Z_{\mathrm{T}} \qquad \text{(A.10)}$$

a) Near end cross-talk $F_\mathrm{n} = \dfrac{U_2^{'}(0)}{U_0}$:

$$F_\mathrm{n} = -\frac{Z_\mathrm{T}^2}{2ZZ_3\gamma_3}\left\{\frac{1-e^{-2\gamma l}}{2\gamma}\left[\frac{\gamma^2\left(\gamma_3^2+\gamma^2\right)}{\left(\gamma_3^2-\gamma^2\right)^2}-1\right]-\frac{\gamma_3\gamma^2}{\left(\gamma_3^2-\gamma^2\right)^2}\frac{\left(1+e^{-2\gamma l}\right)\cosh(\gamma_3 l)-2e^{-\gamma l}}{\sinh(\gamma_3 l)}\right\} \tag{A.11}$$

b) Far end cross-talk $F_\mathrm{n} = \dfrac{U_2^{'}(l)}{U_0}$:

$$F_\mathrm{f} = \frac{Z_T^2 e^{-\gamma l}}{2ZZ_3\gamma_3}\left[\frac{l\gamma_3^2}{\gamma_3^2-\gamma^2}-\frac{2\gamma_3\gamma_2}{\left(\gamma_3^2-\gamma^2\right)^2}\frac{\cosh(\gamma_3 l)-\cosh(\gamma l)}{\sinh(\gamma_3 l)}\right] \tag{A.12}$$

A.3.3 Third circuit matched

A.3.3.1 General

In the case where all three circuits are matched, one obtains:

$$Z_\mathrm{A} = Z_\mathrm{B} = Z_3 \tag{A.13}$$

$$\gamma_1 = \gamma_2 = \gamma \tag{A.14}$$

$$Z_1 = Z_2 = Z \tag{A.15}$$

$$Z_\mathrm{T1} = Z_\mathrm{T2} = Z_\mathrm{T} \tag{A.16}$$

A.3.3.2 Frequency range without restrictions

a) Near end cross-talk $F_\mathrm{n} = \dfrac{U_2^{'}(0)}{U_0}$:

$$F_\mathrm{n} = -\frac{Z_\mathrm{T}^2}{4ZZ_3}\left[\frac{\gamma_3}{\gamma}\frac{1-e^{-2\gamma l}}{\gamma_3^2-\gamma^2}-\frac{1-2e^{-(\gamma_3+\gamma)l}+e^{-2\gamma l}}{\gamma_3^2-\gamma^2}\right] \tag{A.17}$$

b) Far end cross-talk $F_\mathrm{n} = \dfrac{U_2^{'}(l)}{U_0}$:

$$F_\mathrm{f} = -\frac{Z_\mathrm{T}^2 e^{-\gamma l}}{4ZZ_3}\left[\frac{2\gamma_3 l}{\gamma_3^2-\gamma^2}-\frac{1-e^{-(\gamma_3-\gamma)l}}{(\gamma_3-\gamma)^2}-\frac{1-e^{-(\gamma_3+\gamma)l}}{(\gamma_3+\gamma)^2}\right] \tag{A.18}$$

A.3.3.3 Low frequencies

For low frequencies, one obtains:

$$e^{-2\gamma l} \approx 1 - 2\gamma l + 2(\gamma l)^2 \qquad \text{(A.19)}$$

a) Near end cross-talk $F_\mathrm{n} = \frac{U_2^{'}(0)}{U_0}$:

$$F_\mathrm{n} \approx -\frac{Z_\mathrm{T}^2}{4ZZ_3} l^2 \qquad \text{(A.20)}$$

b) Far end cross-talk $F_\mathrm{n} = \frac{U_2^{'}(l)}{U_0}$:

$$F_\mathrm{f} \approx \frac{Z_\mathrm{T}^2}{4ZZ_3} l^2 \qquad \text{(A.21)}$$

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